

AMENDMENT OF THE CLAIMS:

Claim 9 amended:

9. An enhanced volume phase grating comprising:

a rigid support means;

a volume phase medium attached to said rigid support means;

a transparent cover means attached to said volume phase medium with a transparent adhesive to provide a sealant and protectant for said volume phase medium;

the bulk refractive index, n , of said volume phase medium being periodically modulated within the thickness, T , of said volume phase medium in a direction parallel to the surface of said volume phase medium, with a peak value of refractive index equal to $n + \Delta n$, where Δn is the peak modulation of said bulk refractive index, n , the periodic sequence of said peak values of said bulk refractive index throughout said thickness, T , of said volume phase medium creating a periodic structure of Bragg surfaces within said volume phase medium with a period, d , where

said period, d , is established by selecting any two positive integers s and p , such that $s > p$, and any arbitrary external angle of incidence, θ_i , calculating the internal angle of diffraction, β , with the following equation:

$$\underline{\beta = \text{either } a \cos\left(\frac{2p-1}{2s-1}\right) - \alpha \text{ or } 180 - a \cos\left(\frac{2p-1}{2s-1}\right) - \alpha,}$$

where:

$$\underline{\alpha = a \sin\left(\frac{\sin \theta_i}{n}\right)}$$

and using the following equation:

$$d = \frac{\lambda}{n(\sin \alpha + \sin \beta)},$$

where λ is the nominal free-space wavelength for which said enhanced volume phase grating is designed,

$$\alpha + \beta = 2\theta \text{ and}$$

$$2\theta = \text{either } \alpha \cos\left(\frac{2p-1}{2s-1}\right) \text{ degrees or } 180 - \alpha \cos\left(\frac{2p-1}{2s-1}\right) \text{ degrees,}$$

$$\text{where } s \text{ and } p \text{ are integers and } s > p > 0,$$

and said peak modulation, Δn , of said bulk refractive index is obtained from the following equation:

$$\Delta n = \frac{\lambda}{T} \left(\frac{2s-1}{2} \right) \sqrt{(\cos \alpha) \left(\cos \alpha - \frac{\lambda}{nd} \tan\left(\frac{\beta - \alpha}{2}\right) \right)},$$

$$\Delta n = \frac{\lambda}{T} \left(\frac{2s-1}{2} \right) \sqrt{C_R C_S},$$

$$\text{where } C_R = \cos \alpha \text{ and } C_S = \cos \alpha - \frac{\lambda}{nd} \tan\left(\frac{\beta - \alpha}{2}\right);$$

values of said bulk refractive index, n , and said peak modulation, Δn , being established using well known exposure and processing procedures for said volume phase medium;

whereby the S-polarization diffraction efficiency and the P-polarization diffraction efficiency of said enhanced volume phase grating, when illuminated by an incident beam of said nominal free-space wavelength, λ , at an said internal external angle of incidence, θ_i , are simultaneously maximized at a common value of the product $\Delta n T$, thereby simultaneously minimizing insertion loss and PDL in a highly dispersive volume phase grating.

Claim 12 amended:

12. The enhanced volume phase grating of claim 9 wherein said rigid support means is a transparent medium, ~~such as glass or fused silica~~, and said transparent cover means is a similar or identical transparent medium.

Claim 15 amended:

15. The enhanced volume phase grating of claim 12 wherein the external surfaces of said transparent medium and said transparent cover means are coated with an anti-

reflection coating such that the overall loss for the S-polarized light is somewhat greater than the overall loss for the P-polarized light at said nominal free-space wavelength, thereby minimizing the ~~worst-case~~ maximum PDL.

Claim 16 amended:

16. The enhanced volume phase grating of claim 12 wherein the external surfaces of said transparent medium and said transparent cover means are coated with an anti-reflection coating such that the overall loss for the S-polarized light is somewhat greater than the overall loss for the P-polarized light after two passes through said enhanced volume phase grating at said nominal free-space wavelength, thereby minimizing the ~~worst-case~~ maximum PDL in a two-pass design.

Clean version of all eight claims:

9. An enhanced volume phase grating comprising:

a rigid support means;

a volume phase medium attached to said rigid support means;

a transparent cover means attached to said volume phase medium with a transparent adhesive to provide a sealant and protectant for said volume phase medium;

the bulk refractive index, n , of said volume phase medium being periodically modulated within the thickness, T , of said volume phase medium in a direction parallel to the surface of said volume phase medium, with a peak value of refractive index equal to $n + \Delta n$, where Δn is the peak modulation of said bulk refractive index, n , the periodic sequence of said peak values of said bulk refractive index throughout said thickness, T , of said volume phase medium creating a periodic structure of Bragg surfaces within said volume phase medium with a period, d , where

said period, d , is established by selecting any two positive integers s and p , such that $s > p$, and any arbitrary external angle of incidence, θ_i , calculating the internal angle of diffraction, β , with the following equation:

$$\beta = \text{either } a \cos\left(\frac{2p-1}{2s-1}\right) - \alpha \text{ or } 180 - a \cos\left(\frac{2p-1}{2s-1}\right) - \alpha,$$

where:

$$\alpha = a \sin\left(\frac{\sin \theta_i}{n}\right)$$

and using the following equation:

$$d = \frac{\lambda}{n(\sin \alpha + \sin \beta)},$$

where λ is the nominal free-space wavelength for which said enhanced volume phase grating is designed,

and said peak modulation, Δn , of said bulk refractive index is obtained from the following equation:

$$\Delta n = \frac{\lambda}{T} \left(\frac{2s-1}{2} \right) \sqrt{(\cos \alpha) \left(\cos \alpha - \frac{\lambda}{nd} \tan\left(\frac{\beta - \alpha}{2}\right) \right)},$$

values of said bulk refractive index, n , and said peak modulation, Δn , being established using well known exposure and processing procedures for said volume phase medium;

whereby the S-polarization diffraction efficiency and the P-polarization diffraction efficiency of said enhanced volume phase grating, when illuminated by an incident beam of said nominal free-space wavelength, λ , at said external angle of incidence, θ_i , are simultaneously maximized at a common value of the product $\Delta n T$, thereby simultaneously minimizing insertion loss and PDL in a highly dispersive volume phase grating.

10. The enhanced volume phase grating of claim 9 wherein said volume phase medium is dichromated gelatin.
11. The enhanced volume phase grating of claim 9 wherein said index modulation, Δn , of said volume phase medium is greater than 0.1, and preferably on the order of 0.2, thereby decreasing Bragg angle sensitivity.
12. The enhanced volume phase grating of claim 9 wherein said rigid support means is a transparent medium and said transparent cover means is a similar or identical transparent medium.